Attorney's Docket No.: 05918-314001

APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: TOUCH FASTENER CONFIGURATIONS

APPLICANT: HOWARD A. KINGSFORD and WILLIAM H. SHEPARD

CERTIFICATE OF MAILING BY EXPRESS MAIL

Express Mail Label No. EV330507240US

June 26, 2003
Date of Deposit

TOUCH FASTENER CONFIGURATIONS

TECHNICAL FIELD

This invention relates to touch fasteners and closures releasably securing flexible materials.

BACKGROUND

Releasable touch closures, such as hook-and-loop, interlocking stem, and adhesive closures, are commonly employed to releasably connect flexible materials, such as in garments and the like. The primary purpose of such closures is in the connecting of two overlapping materials in a matter that permits easy opening and subsequent re-engagement. Such closures feature engagement over a discrete but significant area, whether an array of individual hooking members or a discrete patch of adhesive, rather than a rotatable point fastening, such as a snap or a button.

SUMMARY

We have realized that, properly arranged, the engagement area of a touch fastener closure can be configured to perform an additional function as an interface between the two engaged materials, other than simply resisting disengagement. In particular, we have realized that as such fastenings can transfer moments or twisting about an axis perpendicular to the plane of engagement, certain engagement area configurations can also effect such twisting as a response to an applied load such as a unidirectional shear load acting within the plane of the fastening.

According to one aspect of the invention, a touch fastener includes a female fastener component in the form of a flexible material carrying a field of fibrous loops, and a male fastener component comprising a flexible web carrying a multiplicity of loop-engageable fastener elements extending from an exposed surface of the male fastener component in a fastening area that includes one or more discrete regions bounded by exposed areas of the web void of fastener elements. The female and male fastener components are each permanently arranged on a product in spaced apart relation and positioned to be overlapped to form a releasable fastening that resists shear force applied in a primary shear loading

direction. The fastening area defines a fastening centroid along an axis extending in the loading direction. At least one of the flexible material of the female fastener component and the flexible web of the male fastener component includes an elastic material, or is at least elastic in the primary shear loading direction. Notably, the fastening area is arranged asymmetrically about the axis so as to induce a twist in the fastening in response to shear force applied in the loading direction.

In some embodiments, the flexible web of the male fastener component is elastic and the male fastener component includes a layer of relatively non-extensible resin permanently secured to the web and from which the fastener element stems are integrally molded.

In some cases, the fastening area comprises multiple discrete regions each bounded by exposed areas of the web void of the layer of resin. Preferably, the flexible web is resiliently stretchable between the discrete regions of the fastening area in the loading direction.

The layer of resin is preferably permanently bonded to the flexible web in the fastening area by resin of the layer encapsulating fibers of the flexible web. In some examples, the fastener elements have individual stems integrally molded with the resin encapsulating the flexible web fibers. In some cases, the layer of resin encapsulates the flexible resin to form a local backing on a side of the flexible web opposite the fastener elements. In some other cases, the flexible web has a side opposite the fastener elements and void of the resin layer.

In some embodiments, the flexible web includes a sheet of elastomeric resin, to which the layer of relatively non-extensible resin is bonded in the fastening area.

For some touch fastener applications, the flexible web is or includes a woven material that is resiliently stretchable at least in the loading direction.

In some configurations, the flexible material of the female fastener component is elastic. For example, the flexible material of the female fastener component may be, or may comprise, a woven material that is resiliently stretchable at least in the loading direction.

The elastic material should be resiliently stretchable in at least the loading direction.

In some embodiments, such as in some of the embodiments described below, the fastening area includes multiple (e.g., two) discrete regions, each region bounded by exposed areas of the web void of fastener elements. In other embodiments, the fastening area consists

of a single, contiguous region bounded by exposed areas of the web void of fastener element. For example, the fastening region may be L-shaped.

In some cases, the fastener elements have individual stems integrally molded with and extending from a surface of the flexible web. The fastener elements also have, in some instances, loop-engageable heads disposed at distal ends of their stems and laterally overhanging the flexible web. In some cases, the heads are integrally molded with their stems.

According to another aspect of the invention, a garment, such as a disposable diaper, has a releasable touch closure as described above, in which the male and female fastener components are spaced apart on the garment and arranged to be overlapped in releasable engagement to secure the garment about a wearer. The fastening area is arranged asymmetrically about a line extending through the centroid of the fastening area in the primary shear loading direction.

In some applications, the closure is arranged to be positioned along a waist of the wearer as the garment is worn.

In some cases, two such closures are positioned spaced apart along an edge of the garment and arranged to each locally induce a twist in the fastening, in response to shear force applied across the edge of the garment, to resist bowing of the garment edge between the closures.

According to another aspect of the invention, a releasable adhesive fastener includes an adhesive fastener component comprising a flexible web carrying a layer of adhesive in a fastening area, and a landing web with an exposed fastening surface configured to releasably adhere to the adhesive when the adhesive is brought into direct with the exposed surface. The fastening area includes one or more discrete regions bounded by exposed areas of the flexible web void of adhesive. The adhesive fastener component and exposed fastening surface are each permanently arranged on a product in spaced apart relation and positioned to be overlapped to form a releasable fastening that resists shear force applied in a primary shear loading direction. The fastening area defines a fastening centroid along an axis extending in the loading direction. At least one of the flexible web of the adhesive fastener component and the landing web includes an elastic material. Notably, the fastening area is

arranged asymmetrically about the axis so as to induce a twist in the fastening in response to shear force applied in the loading direction.

According to another aspect of the invention, a garment, such as a disposable diaper, has a releasable adhesive closure as described above, in which the adhesive and fastening surface are spaced apart on the garment and arranged to be overlapped in releasable engagement to secure the garment about a wearer. The fastening area is arranged asymmetrically about a line extending through the centroid of the fastening area in the primary shear loading direction.

The term "centroid," as used herein with respect to a planar area, is to be understood as having its standard meaning. The location of the centroid with respect to a given axis within the plane of the area is derived as the double integral over the area of the product of the distance from the axis and the incremental area, divided by the overall area.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

Fig. 1 is a geometric illustration of a touch fastening area with two discrete fastening regions.

Fig. 2 illustrates an induced twist in response to a shear force applied to the fastening area of Fig. 1.

Fig. 3A shows a closure with the fastening area of Fig. 1.

Fig. 3B illustrates the closure of Fig. 3A under a shear load.

Figs. 4A and 4B illustrate a strap closure with a contiguous asymmetric fastening area, under unloaded and loaded conditions, respectively.

Fig. 5 shows a strap closure with a triangular, asymmetric fastening area.

Fig. 6 shows a strap closure with an L-shaped, asymmetric fastening area.

Figs. 7A and 7B conceptually illustrate one application of asymmetric fastening areas for the reduction of inter-closure gapping along a garment edge.

Fig. 8 shows a disposable diaper with asymmetric fastening area closures.

Fig. 9 is a cross-sectional view of a male fastener component with patches of resin laminated to an elastomeric sheet substrate.

Fig. 9A is an enlarged view of a portion of the fastener component of Fig. 9.

Fig. 10 is a cross-sectional view of a male fastener component with patches of resin laminated to a woven substrate material.

Fig. 11 is a cross-sectional view of a male fastener component with patches of resin laminated to a non-woven substrate material.

Fig. 11A is an enlarge view of area 11A in Fig. 11.

Fig. 12 is an enlarged cross-sectional view of a male fastener component with mushroom-type fastener elements formed of resin laminated to a non-woven substrate with exposed loops.

Fig. 13 shows a strap closure with an adhesive, asymmetric fastening area.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

Referring first to Fig. 1, the fastening area 10 of a releasable touch fastener closure, such as a hook-and-loop closure, is composed of two discrete regions 12a and 12b, in this example two equal areas of square shape. The fastening area 10 is the area of the closure in which connection is made between mating fastener components. In the case of a hook-and-loop fastener, for instance, the fastening area includes all of the hooking elements of the closure. In an adhesive closure, all of the adhesive is contained within the fastening area. In most hook-and-loop examples, there will be a large number of discrete hook elements within each bounded, discrete area, with the density of hook elements relatively constant across the area. However, it is possible to have a fastening area with a central region void of hooking elements, in which case such a central area is not included in the fastening area. Likewise, it is possible to have a single outlying fastener element that, if operable in the fastening, would define its own discrete area. In most cases with hook-and-loop fastenings, however, the fastening area 10 will consist of one or a very few discrete regions, each region having a large number (e.g., 30 or more) individual fastening elements. In such cases, the fastening elements in each discrete region are considered as operating in concert to resist a loading.

Each discrete region 12a and 12b is relatively inelastic, within the plane of the closure, compared to at least one of the substrates of the closure in the area between the discrete regions.

Fastening area 10 defines an area centroid 14, in this case directly between the two discrete areas. As a linear shear force 'F' acts on the closure, applied initially along a force axis 16 extending through centroid 14, each discrete region 12a and 12b resists a corresponding portion of the shear force.. Because of elasticity within the closure, the region 12b closest to the applied load 'F' will carry a load F_b that is quantitatively greater than the load proportion F_a carried by region 12a. As a result, the net force 'F' will act on the closure at a point above axis 16. There will also be some stretching, in the direction of force 'F', in the closure between regions 12a and 12b, and region 12b will be the first region to carry load as the load 'F' is applied.

In response to applied load 'F', closure 10 will also undergo some twisting within the plane of the closure, as illustrated in Fig. 2. In this figure, the balancing loads provided by the other half of the closure are shown in dashed outline. Lines 18 running parallel to the force axis in the unstressed condition are also shown, illustrating that the closure and the substrates it connects undergoes a local twisting about centroid 14. Each of the relatively inelastic regions 12a and 12b of the fastening area 10 have been twisted within the plane of the closure by an angle θ, shown exaggerated for purposes of illustration. In addition, a secondary force component F_s is introduced by the twisting in response to shear force 'F', acting at each discrete region 12a and 12b in a direction perpendicular to the applied load. This secondary force is induced as a tension in the substrate to which the fastener components are attached, and can be considered a reaction to the discrete regions 12a and 12b moving closer to the force axis 16 as a result of the twisting about centroid 14. This secondary force, although small in comparison to applied shear load 'F', can be put to use in various applications.

Fig. 3A shows a hook-and-loop closure 20 with the fastening area 10 of Fig. 1, with a male fastener component in the form of a tab 22, engaging a female loop component in the form of a sheet material 24 having a free edge 26. In this view, the closure is unloaded. Fig. 3B shows the same closure with shear load 'F' applied. At equilibrium in the twisted position shown, the moment 'M' induced by offset shear load couple 'F' about centroid 14 is

balanced by a moment caused by induced force couple F_c acting on tab 22 through closure 20. Loads F_c are balanced in the female fastener component 24 by induced secondary forces F_s. Hook patches 12a and 12b are each slightly rotated with respect to the loading direction by the local twisting of the tab and loop material.

Fig. 4A shows an unloaded touch fastener closure with a fastening area 10a that is one contiguous area defining a centroid 14a but asymmetric about a loading direction extending horizontally across the figure along the two mated straps 28 and 30. Upon application of a shear load 'F', as shown in Fig. 4B, fastening area 10a is distended and twisted about centroid 14a, inducing a slight, local 'kink' in the mated straps.

Fig. 5 shows a similar strap connection with a triangular, contiguous fastening area 10b, asymmetrically arranged about a centroid 14b with respect to a primary loading direction extending along the straps. Similarly, Fig. 6 shows an L-shaped fastening area 10c, asymmetrically arranged about a centroid 14c with respect to a primary loading direction extending along the straps. Other fastening area shapes and arrangements are also envisioned.

Fig. 13 shows a fastening area 10c defining a centroid 14c and composed of two discrete, circular regions 12c and 12d containing an adhesive 60. The adhesive is applied to one of the two mated straps 28 and 30 to cover just the fastening area, and releasably adheres the two straps together in the circular regions. Pressure-sensitive adhesives are envisioned, as are other types of manually releasable adhesives.

Figs. 7A and 7B illustrate one application of asymmetrically arranged fastener areas, in closures along a garment edge. Fig. 7A illustrates with some exaggeration the deformation that can occur along a garment edge between spaced-apart closures 32, such as along the front of a shirt with closures 32 for buttons. Due to the flexibility and elasticity of the garment material, the overlapping edges of material are bowed away from each other in the space between the closures when a uniform, lateral shear load 'F' is applied to the series of closures, in some cases far enough to create a visible gap 34 where the overlap is eliminated. By replacing closures 32 with asymmetrically arranged closure areas 34, twisting induced locally at each closure 34 by applied shear load 'F' can act to reduce the bowing of the garment edges. Of course, the degree of gap reduction will be a function of several factors,

including the spacing along the garment edge between fasteners, the elasticity of various regions of the garment, and the configuration of each closure 34.

Fig. 8 illustrates the above principles as applied to a closure for a disposable diaper 36. It is common for such diapers to have releasable closures in the form of diaper tabs 38 that extend from a rear panel of the diaper chassis to be brought about the waist of an infant to overlap the front panel of the diaper. The stretchable tabs 38 frequently carry male fastener elements that releasably engage a loop region 40 on the front of the diaper to secure the diaper about the waist of the infant. In the illustrated example, the male fastener elements of each tab 38 are arranged in the fastening area 10 discussed above with respect to Figs. 1 and 2. Engaged about the infant, tension along the stretchable tabs 38 acts as an applied shear force 'F' that induces some twist 'T' at each fastening closure 10. This twist tends to rotate the central portion of the front panel loop region 40 upward, resisting sagging of the front of the diaper that can lead to undesirable gaps between the diaper waistband and the infant's abdomen.

For applications in which the male fastener component is elastic, the female fastener component can be any of several available types, including woven or knit materials, or non-woven materials. For applications in which the female fastener component is elastic, various types of loop material are also available, including stretchable woven or knit materials (such as Loop 151 or Loop 152, available from Velcro USA in Manchester, New Hampshire), and stretchable non-woven materials.

Figs. 9 through 11 illustrate various constructions of male fastener products having fastener elements extending from discrete patches of resin joined to a substrate. Referring to Fig. 9, for example, patches 12a and 12b of hooks are formed of resin locally laminated to a preformed film or sheet 42 and molded to form an array of hook-shaped fastener elements 43, shown enlarged in Fig. 9A. If sheet 42 is formed of an elastomeric resin, and the resin of patches 12a and 12b is relatively inelastic by comparison, the overall male fastener component will exhibit some elasticity in areas other than those covered by the hook patch resin. The opposite side of sheet 42 remains, in this example, free of hook patch resin. In Fig. 10, a male fastener component has a woven substrate 44 onto which molten resin has been applied in discrete patches and solidified to form an array of fastener element stems 46 that are subsequently deformed to form loop-engageable fastener elements 48. Such fastener

elements 48 are also shown in Fig. 12, formed of resin laminated to one side of a non-woven material 50 carrying hook-engageable loops 52 on its opposite side. The hook patch resin of the product of Fig. 10 fully encapsulates the woven substrate 44, forming a discrete backing 54 on the opposite side of the substrate. If woven to have some elasticity in a given direction, the substrate will retain that elasticity in areas not confined by the presence of the hook patch resin.

Fig. 11 shows another male fastener component, with discrete patches 12a and 12b of resin laminated to one side of a non-woven substrate 56. Integrally molded with the resin is an array of fastener element stems 46 upon which engageable heads may later be formed. As shown in the enlarged view of Fig. 11A, some of the resin encapsulates individual fibers of substrate 56 to permanently bond the resin to the non-woven, without flooding the opposite side of the substrate.

The composite products illustrated in Figs. 9 through 12 can be fabricated by the type of process disclosed in Kennedy et al., U.S. Patent No. 5,518,795, the method and apparatus disclosure of which is incorporated herein by reference. Discrete patches of fastener elements may be formed, for example, by depositing discrete puddles of molten resin on the substrate before it enters the stem-molding nip. Alternatively, discrete patches of molded fastener element tape can be laminated or otherwise secured individually to a substrate. Discrete patches of woven fastener element tape can be secured to the substrate with adhesives or stitching, for example.

A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are within the scope of the following claims.